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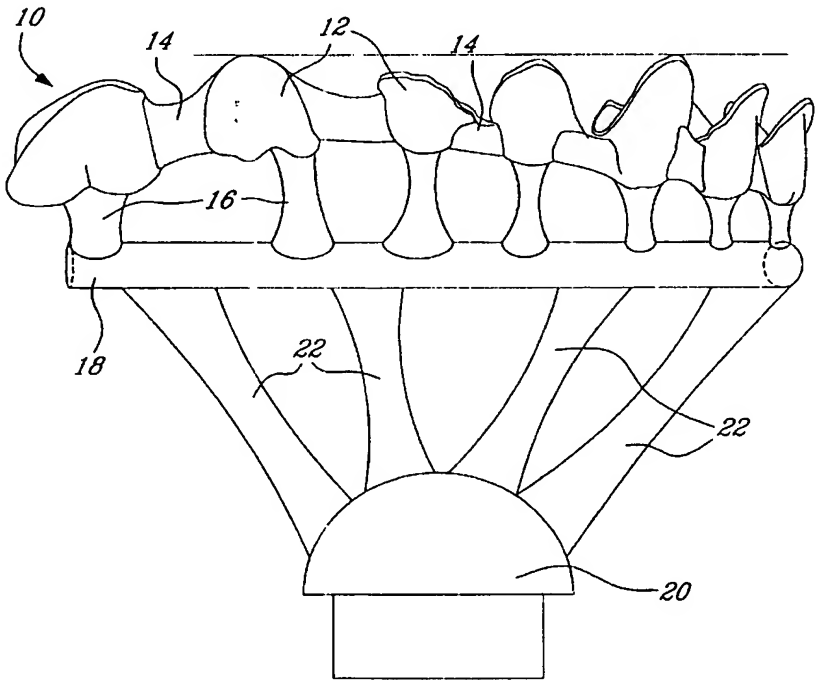
(54) Titre : METHODE DE PRODUCTION DE MOULES POUR PIECE COULEE
(54) Title: METHOD FOR PRODUCING CASTING MOLDS



(57) Abrégé/Abstract:
A method to design and manufacture casting mold for dental prostheses and a wax model for dental prosthesis are described herein.

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ABSTRACT OF THE DISCLOSURE

A method to design and manufacture casting mold for dental prostheses and a wax model for dental prosthesis are described herein.

TITLE OF THE INVENTION

METHOD FOR PRODUCING CASTING MOLDS

FIELD OF THE INVENTION

The present invention relates to the production of custom-made casting molds. More specifically, the present invention is concerned with a method used to cast molds for dental prostheses and to such molds.

BACKGROUND OF THE INVENTION

The conventional approach to produce custom casting molds has traditionally been the lost wax casting process. This process is based on the following principle:

- A model or pattern of the desired finished product is made in wax;
- This pattern is mounted with sprues and reservoirs to support the pattern in the desired casting position, provide passageways for wax elimination and form lines through which molten metal enters the mold;
- This pattern is surrounded by a creamy investment plaster that hardens to form a mold;
- This mold is heated to melt away the wax pattern that is then "lost";

- Metal is then cast into the cavity left by the "lost wax", thus duplicating the original wax pattern (the quantity of metal is calculated based on measurements of either the weight or the volume of the wax pattern);
- The mold is then destroyed to recover the casting.

This process dates back in time beyond Egypt's pyramids. Examples of castings include the Shang Dynasty in China, 16th Century Europe and the Aztecs of Mexico, to name a few, are monuments to the abilities of casters down through the ages. Today, the process is becoming even more popular because of the need for a near-finished casting.

Refinements of this process were developed by a dentist in 1907, and applied to the casting of gold inlays and dental bridgework. Today's craftsmans apply the very same techniques in making parts for models, fishing lures, specialized machine components and endless pieces of jewelry.

Since every detail created in the surface of the finished wax model will ultimately be re-created in metal when the casting is complete, special care taken in making the wax pattern can minimize the finishing and polishing steps later.

To produce dental prostheses, the dental laboratory technician typically duplicates the patient teeth in plaster from an impression provided by a dentist, then uses the lost-wax method to realize a casting mold, then invests the mold in the casting oven filling it with

metal in fusion to build the substructure components of dental prostheses, then porcelain is applied and fused on the metal substructure to complete the prosthetic work. The casting oven either uses the centrifuge effect principle or a vacuum chamber.

The lost-wax method to realize a casting mold therefore generally consists of the following steps:

1. Apply die spacer on the surface of the plaster die to emulate the cement space;
2. Realize the prosthesis out of wax (by dipping and wax-up technique);
3. Add wax pouring sprue (off-the-shelf item) on top of the wax prosthesis;
4. Add several prosthetic elements with pouring sprues on top of an investment tree (off-the-shelf element or not) with an adequate casting reservoir;
5. Add wax cooling sprues and vent sprues (off-the-shelf items) when desirable;
6. Install the wax ensemble in an investment cylinder;
7. Invest the ensemble with a refractory material (heating will eliminate the wax and result in a negative mold of the ensemble: casting reservoir, tree, sprues, prosthesis).

However, the lost-wax method is labor-intensive and also requires dexterity to manipulate this fragile wax structure without breaking it, twisting it or otherwise distorting it. Furthermore, the use of out-the-shelf items constrains the design of the casting mold.

The computer-aided design and manufacturing of the prosthesis is an alternative method for producing dental prosthesis. This method is typically used in conjunction with computer-controlled milling machines. Blanks are milled into prostheses. However, with this process, a large proportion of the blank material is rejected. When the prosthesis substructure is composed of a precious alloy, the scrap metal represents more value than the prosthesis itself.

OBJECTS OF THE INVENTION

An object of the present invention is therefore to provide an improved wax casting mold and method for making same.

Other objects, advantages and features of the present invention will become more apparent upon reading of the following non-restrictive description of preferred embodiments thereof, given by way of example only with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the appended drawings:

Figure 1 is a perspective view of three wax models according to the present invention used to produce casting molds;

Figure 2 is a side elevational view of a wax model according to the present invention, including several prosthesis; and

Figure 3 is a bottom plan view of the wax model of Figure 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

According to the present invention, there is provided a method to design and manufacture casting mold for patterns, particularly dental prostheses and to wax models to create such casting molds. This method will be referred herein as the Waxpro™ system.

Generally stated, the method of the present invention comprises following steps:

1. Designing the prosthesis using computer-aided design (CAD) tools such as Cynovad's Pro 50™ scanner and CAD software;
2. Designing the conduits and reservoirs configuration as well as the mold container using CAD tools to support multiple patterns in the desired casting position, provide passageways for wax elimination and form lines through which molten metal enters the mold;
3. Realizing the designed structure using a low fusion temperature material such as wax and a rapid prototyping machine such as that of *Thermojet*™ by 3D System Inc.;
4. Invest the ensemble with a refractory material (heating will eliminate the wax and result in a negative mold of the ensemble: casting reservoir, tree, sprues, prosthesis);

Each of these steps will now be described in more detail.

In step 1, quantitative data on shape of the patient's teeth is advantageously acquired by a digital 3D scanner either directly in the patient's mouth or on a model made from an impression made by the dentist; then the morphology of the prosthesis is advantageously produced using CAD software. In particular, the regularity of the coping thickness obtained with machine precision ensures that structural specifications are met with the minimal quantity of metal and no rework.

The digital measurements of the shape of teeth, such as those obtained by devices and methods described in United States Patents Nos 4,611,288, 4,663,720, 4,742,464, 4,952,149, 5,092,022 and 5,237,998which are herein included by reference. It is to be noted that other devices may also be used without departing from the spirit and nature of the present invention.

In step 2, the positioning of the prosthetic elements, the design of the conduits and reservoirs configuration given the custom-made prostheses to invest, and the casting mold external shape is advantageously produced using a computer-aided design software tool. The conduits and reservoirs are custom shaped and positioned to minimize the quantity of metal needed while improving the invested metal flow in order to fill completely the prostheses and allowing the crystallization to begin simultaneously where the highest precision is needed, thus ensuring the quality of the prosthetic work. The design is

optimized given the fluid dynamics properties of the chosen metal alloy. The computer simulation of casting process provides the preferred analysis tool. The manufacturing of the ensemble (the pattern, the wax conduit and reservoir elements, the mold external wall) in a single piece allows for the precise placement of tiny fragile vent sprues close to the hot metal mass and cooling sprues close to the mold external wall. Furthermore, the pouring sprue leading to each prosthetic element can automatically be marked to identify it, as well as the casting cone and mold external wall. Finally, the mold external wall can be shaped and/or marked to indicate the optimal orientation when place in the casting oven.

In step 3, the designed structure combining the prostheses, the conduits and reservoirs configuration, and the external wall of the mold is advantageously realized using a process such as the rapid prototyping machine of 3D System Inc.. It is to be noted that other devices may also be used without departing from the spirit and nature of the present invention.

Step 4 is the same as the typical approach used by dental technician to produce a casting mold that is investing the designed structure with a refractory material. Vibration is used to facilitate the flow. Heating eventually eliminates the wax and result in a negative mold of the casting reservoir, sprues and prosthesis.

The appended figures illustrate realizations of wax models for dental prosthesis according to the present invention.

More specifically, Figure 1 illustrates three wax models constructed according to the principle of the method of the present invention in perspective view. These wax models are intended to be used to create casting molds.

Figures 2 and 3 respectively illustrate side elevation and bottom plan views of a wax model 10 comprising a plurality of prostheses 12 interconnected by connectors 14. The prostheses 12 are mounted on individual sprues 16 connected to a reservoir 18 itself connected to a master inlet 20 via primary sprues 22.

As will easily be appreciated by one skilled in the art, the use of a computer modelling tool allows the design of custom investment tree suited for the number, dimensions and position of the dental prosthesis. Furthermore, it allows a perfect positioning of the prostheses with respect to the reservoir to thereby improve the success rate of the casting steps.

An advantage of the WaxPro™ system compared to the traditional way is the time saving linked with the automation of many steps involved in the process that are carried in parallel: for example, it is possible to start scanning the next batch of prostheses and creating the CAD models while the waxing machine is making previous ones. A waxing machine, like the ones used in the rapid prototyping field, is also capable to make several ensembles (conduits, reservoirs, and prostheses) in a single session.

Another advantage of the WaxPro™ system is that it does not require the dental laboratory technician to go through a long and tedious manual procedure in which the manipulation of fragile wax pieces can be awkward and yield a significant percentage of costly remakes. The computer-aided design of the conduits and reservoirs ensemble minimizes the quantity of precious alloy needed, thus cost, and it prevents cavities resulting from bubble formation during the casting step thus avoiding another cause of remakes. The CAD system automatically provides the precise quantity of metal needed, time is saved. Yet another advantage of the Waxpro™ system is the referencing of the different prosthetic elements and the different casting mold; this feature also to save time after and ease quality control.

Finally, this system gives a more controlled result in, for example, the regularity of the thickness of the prosthesis obtained. The resulting quality saves time and precious metal after by avoiding lengthy polishing step before applying the porcelain.

To design the wax model, a digital library of predefined investment trees is used. Of course, the system allows the user to create his own tree via a "*tree edition software*" where the user can change different parameters of dimension, diameter of the different parts of the tree, size of the reservoir, so it is customized every time depending on the shape of the parts (simple copings, bridges, etc...) and the metal that will be used for casting. An expert system may also be used to determine the optimum dimensions of these elements according to the prosthesis to be made.

Although the present invention has been described hereinabove by way of preferred embodiments thereof, it can be modified, without departing from the spirit and nature of the subject invention as defined in the appended claims.

WHAT IS CLAIMED IS:

1. A method to design and manufacture casting mold for dental prostheses generally as shown and described herein.

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2. A wax model to be used in the making of a casting mold for dental prosthesis generally as shown and described herein.

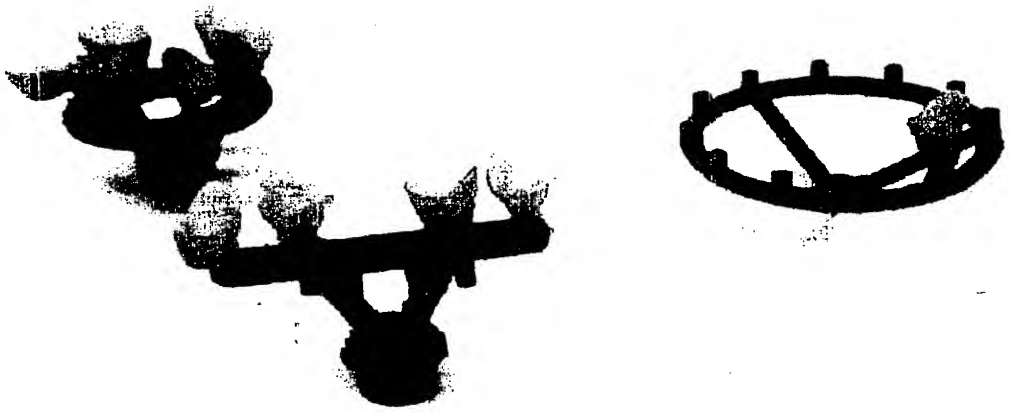

FIG. 1

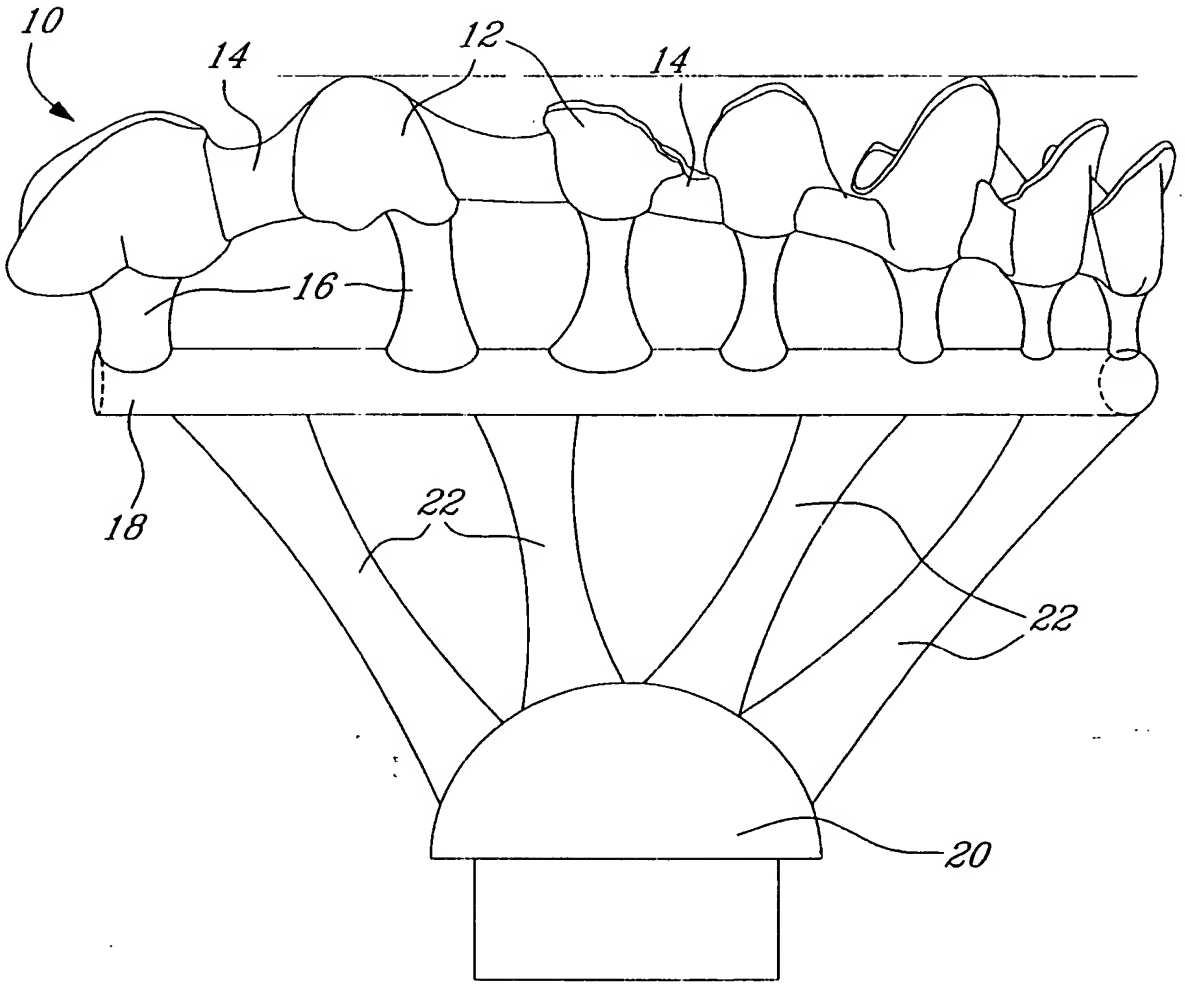

Fig. 2

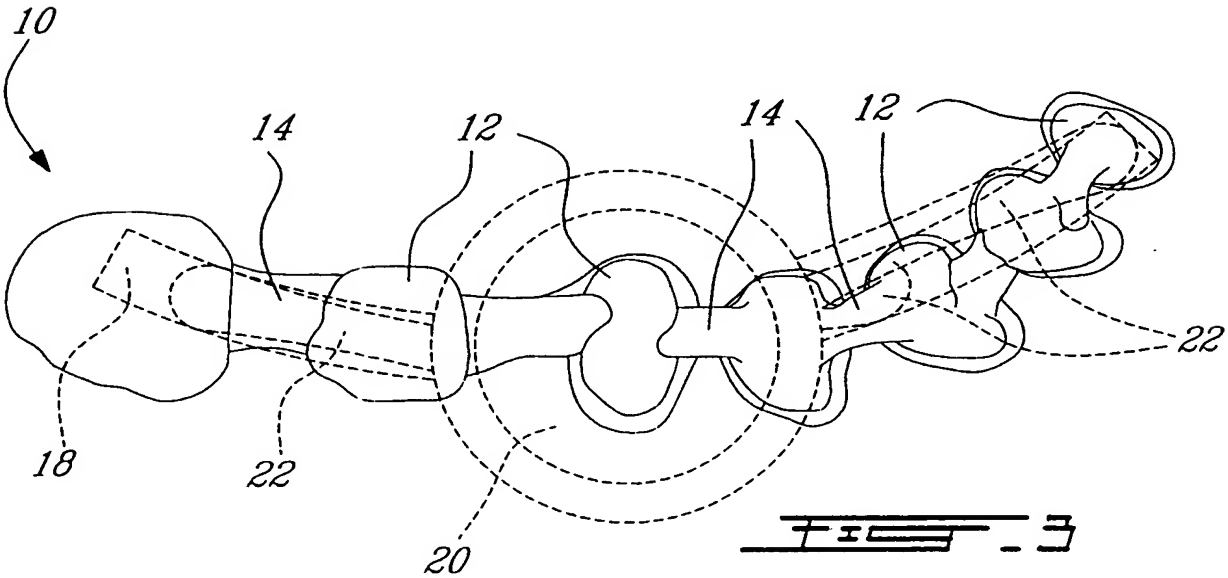

Fig. 3

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